LAND USE

Historical Land Cover/Land Use

Henry Rowe Schoolcraft provides, perhaps, the best early (1821) account of what types of land cover existed within the North Fork Watershed. This is due, in part, to the fact that he and his companion, Levi Pettibone, traveled nearly the entire length of the North Fork River in 1818. Schoolcraft (1821) described the upper portion of the river as being " wholly composed of springs which gush at almost every step from its calcareous banks" and the water as "very pure, cold, and transparent". He mentions "rich bottom lands, covered with elm, beech, oak, maple, sycamore, and ash". He continues to describe bottom lands covered with "luxuriant growth of forest-timber, shrubs, vines, cane, and greenbriar, often so matted and interwoven together, that our progress is not only retarded, but attended with great fatigue". Schoolcraft and his companion, fatigued by the impeded progress in the valley of the North Fork River, moved to the uplands between the North Fork and Bryant Creek, the largest tributary in the watershed. Schoolcraft described this area as "an open barren, with very little timber, or under-brush, and generally level". The broader, more gently sloping uplands are believed to have been composed of open woodlands with occasional prairie and savanna openings with post oak and black oak being the principal tree species (MDC 1997). The land cover of the more dissected landscape nearer the North Fork River and Bryant Creek are believed to have been primarily composed of oak and oak-pine forest with a mixture of hardwoods in the bottoms. Two "pineries" are known to have existed within the North Fork Watershed area in the mid 1800s which encompassed approximately 220 square miles (Smith 1990).

The Ozarks are believed to have first been explored approximately 14,000 years ago by semi nomadic Native American tribes which subsisted as hunters and foragers (Rafferty 1980, Jacobson and Primm 1994). Approximately 1000 B.C., tribes on the fringes of the Ozarks became less nomadic, existing in more permanent villages and incorporating agricultural practices as a means of subsistence. Tribes in the Ozarks interior did not begin adopting these practices until A.D. 900. By A.D. 1500 this culture had disappeared as large agricultural base villages began to grow along the eastern fringe of the Ozarks and the Mississippi River. During this period the interior of the Ozarks was used primarily as a seasonal hunting ground as well as a source for flint and chalcedony for making tools. It is believed that a climatic shift to cooler, drier summers and the resulting failure of maize crops on which early agriculture was based, may have caused an abrupt abandonment of the larger villages. Remnants of these villages and tribes reassembled to form the Osage Tribe which existed throughout much of the Ozarks and was present as European settlement of the area began to occur in the late 1700s and early 1800s (Jacobson and Primm 1994). Native American use of fire, as well as naturally occurring incidences of fire (i.e. lightening strikes), are believed to have been a large determining factor in the types of vegetation found by Schoolcraft and others as exploration of the Ozarks interior began to occur after the Louisiana Purchase of 1803. Native Americans are believed to have set fires for many reasons from harassment of enemies to aiding in hunting. These fires stimulated warm-season grasses such as bluestem and eliminated woody undergrowth thus creating open woodlands or savannas.

European settlement of the Ozark fringe began in the early 1700's under French and, later, Spanish political control. After the Louisiana Purchase of 1803, American settlers began settling the same areas earlier occupied by the Spanish and French. The Osage, in treaty with the federal government, relinquished claims to much of the Ozarks interior in 1808. However, the Osage refused to relinquish their hunting rights in this area (Rafferty 1980). Settlement of the Ozarks interior increased after the war

of 1812 (Jacobson and Primm 1994). However, the region remained sparsely settled until the late 1800's. Many of the early settlers came from states such as Indiana, Illinois, Kentucky, Virginia, and Tennessee (Rafferty 1983). Most of these states were previously considered the frontier prior to the Louisiana Purchase. Many of these settlers brought along skills they had learned for survival in frontier territory. Early settlers subsisted by hunting and fishing as well as maintaining gardens in the small bottomland areas which they cleared. In addition, early settlers raised livestock which grazed on the open range of the slopes and uplands in the summer. In the winter, livestock were fed from forage crops cultivated and harvested from the bottom lands (Jacobson and Primm 1994). The annual practice of burning was continued by early settlers in order to enhance the livestock forage of the uplands. In addition to the influx of settlers of European origin which occurred after the war of 1812, Native American tribes such as the Cherokee, Shawnee, and Delaware which had been displaced from the East began moving through the region (Piland 1991). As the population of the area increased, more settlers were forced to settle the uplands (Smith 1990). Fenced pasture began to replace the practice of open range. These two factors reduced the use of fire on the uplands thus decreasing the grassland and savanna type land cover (Smith 1990; Jacobson and Primm 1994). This region remained sparsely settled until the late 1800's, when the economic values of the vast timber resources were discovered.

The distribution of the first extensive commercial timber cutting in the Ozarks was limited by the distribution of shortleaf pine and transportation routes provided by rivers and railroads (Jacobson and Primm 1994). The timber industry was an important component in the economy of small communities in the North Fork Watershed, although probably not on as large a scale as areas of the Eastern Ozarks such as the Current and Eleven Point Watersheds. Large areas of pine are reported to have existed within the watershed. Geologist B.F. Shumard told of many sawmills in the area in 1853-54. These mills produced lumber which was then hauled by ox team to growing communities such as Springfield, Bolivar, and Linn Creek (Robins 1991a). Timber harvest estimates in Douglas County from around the turn of the century indicate that average annual timber product shipments were approximately 3,000 railroad ties, 4,800 fence and mine posts, 1,200,000 board feet of hardwood lumber, and 680 pieces of piling (Williams 1904). The pine forest during this time was being harvested at a rate of "2,500,000 feet annually" (Williams 1904).

As the logging industry began to decline in the area, residents turned increasingly toward farming as a means of survival. In 1904, the counties of Howell and Douglas had approximately 154,000 acres (26%) and 126,885 acres (25%) under cultivation respectively (Williams 1904). Williams (1904) states that in 1904 Ozark County had 79,085 acres (16%) of "improved farmlands". Estimates of 1899 cropland within Douglas, Howell, and Ozark Counties indicate combined harvested acres of wheat and corn were 58,366; 77,943; and 44,208 respectively (Table Lu01) (MASS 1999). This land use would have undoubtedly contributed significantly to erosion and thus sedimentation and an increased gravel load in the streams of the watershed. As the century progressed, much of the area was found to be unsuitable for this endeavor. Thus began a period of emigration from the region which, except for a period during the Great Depression, would continue through the 1970s (Robins 1991b).

In the early 1930s, a large portion of land within the North Fork Watershed was purchased by the federal government for the creation of the Mark Twain National Forest (Robins 1991c). Initial natural resource development was accomplished by the Civilian Conservation Corps (CCC); a work program of the Great Depression. Thus began the era of natural resource management in the area.

An evaluation of present (1993) conditions of Ozark streams, pre-settlement period historical

descriptions, stratigraphic observations, and accounts of oral-history responses on river changes during the last 90 years, led Jacobson and Primm (1994) to the conclusion that Ozark streams are disturbed from their natural conditions. They state that this "disturbance has been characterized by accelerated aggradation of gravel, especially in formerly deep pools, accelerated channel migration and avulsion, and growth of gravel point bars". Jacobson and Primm (1994) also suggest that "land use changes have disturbed parts of the hydrologic or sediment budgets or both".

Although detailed data from the North Fork Watershed has not been compiled, Jacobson and Primm (1994) summarized the land use changes from pre-settlement conditions to the 1970's in the Jack's Fork Watershed (Table Lu02), which borders the North Fork Watershed to the Northeast as follows:

" Different types of land use have taken place on different parts of the landscape, and at different times, resulting in a complex series of potential disturbances. Uplands have been subjected to suppression of a natural regime of wildfire, followed by logging, annual burning to support open range, patchy and transient attempts at cropping, a second wave of timber cutting, and most recently, increased grazing intensity. Valley side slopes have been subjected to logging, annual burning, and a second wave of logging. Valley bottoms were the first areas to be settled, cleared, and farmed; removal of riparian vegetation decreased the erosional resistance of the bottom lands. More recently, some areas of bottomland have been allowed to grow back into forest. The net effects of this complex series of land-use changes are difficult to determine and separate from natural variability."

Jacobson and Primm (1994) offer the following observations which summarize the probable, qualitative changes to runoff, soil erosion, and riparian erosional resistance on parts of the Ozarks landscape relative to man's impact: " 1. Initial settlement of the Ozarks may have initiated moderate channel disturbance because of decreased erosional resistance of cleared bottom lands. This trend would have been countered by decreased annual runoff and storm runoff that accompanied fire suppression in the uplands.

2. Because of low-impact skidding methods and selective cutting during initial logging for pine during the Timber-boom period, logging would have had minimal effects on runoff and soil erosion. Low-impact methods and selective cutting continued to be the norm in timber harvesting of hardwoods until the late 1940's, when mechanization and diversified markets for wood products promoted more intensive cutting. Locally, log and tie jams, tie slides, and logging debris may have added to channel instability by diverting flow, but because aggradation and instability also occurred on streams not used for floating timber, these factors were not necessary to create channel disturbance.

3. Significant channel disturbance probably began in the Timber-boom period because of continued clearing of bottom land forests and road building in the riparian zone. This hypothesis is supported by evidence that significant stream disturbance began before the peak of upland destabilization in the post-timber-boom period. Extreme floods during 1895 to 1915 may have combined with lowered erosional thresholds on bottom lands to produce the initial channel disturbance.

4. The regional practice of annual burning to maintain open range had the most potential to increase annual and storm runoff and soil erosion because of its considerable areal extent and repeated occurrence. Burning would have been most effective in increasing runoff and erosion on the steep slopes that had been recently cut over during the timber boom. Generally, accelerated soil erosion was not observed after burning, and relict gullies presently (1993) are not apparent on valley-side slopes and uplands. These observations support the hypothesis that burning did not produce substantial quantities of sediment.

5. The greatest potential for soil erosion on valley slopes and upland areas occurred during the post-timber-boom period when marginal upland areas were cultivated for crops. Accelerated erosion of plowed fields was observed and noted by oral-history respondents and by soil scientists working in the Ozarks during the post-timber-boom period.

6. Valley bottoms have the longest history of disturbance from their natural condition because they were the first to be settled, cleared, and farmed. The lowered resistance to stream erosion that results from removing or thinning riparian woodland would have been a significant factor, especially on small to medium sized streams for which bank stability and roughness provided by trees are not overwhelmed by discharge. Disturbance of bottom land riparian forest increased as free-range grazing, crop production, and use of valley bottoms for transportation expanded and reached a peak in the post-timber-boom period. Headward extension of the channel network because of loss of riparian vegetation may have increased conveyance of the channel network (and hence flood peaks downstream) and removed gravel from storage in first and second order valleys at accelerated rates. This hypothesis is supported by a lack of other source areas for gravel and by observations that gravel came from small stream valleys, not off the slopes.

7. During present (1993) conditions, channel instability seems somewhat decreased in areas where the riparian woodland has recovered, but stability is hampered by high sedimentation rates because of large quantities of gravel already in transport and effects of instability in upstream reaches that lack a riparian corridor.

8. Land use statistics indicate that the present trend in the rural Ozarks is toward increased populations of cattle and increased grazing density. This trend has the potential to continue the historical stream-channel disturbance by increasing storm runoff and sediment supply and thus remobilization of sediment already in transit."

Figures Lu01 and Lu02 show trends in livestock and human populations in the three primary counties of the North Fork Watershed (Douglas, Howell, and Ozark). Livestock populations in all three counties have experienced similar trends throughout the period of record (MASS 1999). The data indicates that the largest increase in livestock populations occurred in the 1970s. These populations have actually leveled off or declined since 1980.

Human population in Douglas and Ozark Counties have experienced similar trends in comparison to each other (OSEDA 1998). Populations of both counties have decreased since the turn of the century. However, populations have experienced a slight increase since 1970. Data indicates that the Howell County population trend was similar to those of Douglas and Ozark County until 1940. After 1940 populations of Douglas and Ozark Counties experienced a significant decrease while the population of Howell County remained relatively stable. Since 1970 the population of Howell County has significantly increased.

The 1990 human population within the North Fork Watershed was estimated to be 18,052 (Blodgett J. and CIESIN 1996). Population density in 1990 was approximately 13 persons per square mile as compared to the overall population density for Missouri which was approximately 73 persons per square mile (Figure Lu03). Of course, one must take into account the effect of the states urban centers on this estimate.

Projections of human population increase of Missouri counties have been calculated by the Missouri

Office of Administration (MOA), Division of Budget and Planning for three different projection scenarios in a report entitled "Projections of the Population of Missouri Counties By Age, Gender, and Race: 1990 to 2020" (MOA 1994). Combined population estimates for Howell, Douglas, and Ozark Counties from 1990-2020 have been used to calculate percent increase in population for all three scenarios. The scenarios project a combined population increase of 6.2% to 25.3% by the year 2020.

Ecological Classification

The Ecological Classification System (ECS) is a management tool which provides a means of "describing distribution of current and potential natural resources in a manner that considers land capability upfront" using a knowledge of landform, geology, soils, and vegetation patterns (MDC 1997a). There are several levels of classification within the ECS. For purposes of this document the three lowest levels are dealt with. These levels are, in descending order, section, subsection, and land type association (LTA). The North Fork Watershed lies within the Ozarks Highlands Section and intersects 3 subsections and 14 LTAs.

The Ozark Highlands Section consists of very old and highly weathered plateaus which, coupled with its physigraphic diversity and central geographic location relative to the continent, has created a region of unique ecosystems harboring many endemic species.

The subsections intersected by North Fork Watershed include the White River Hills, and the Central Plateau. The White River Hills Subsection "is characterized by hilly dissected lands associated with the North Fork and Bryant Creek valleys. These streams cut principally through Roubidoux and upper Gasconade formations, yielding mainly deep cherty, heavily weathered soils favored by oak-pine woodlands and forests. Gently rolling, moderately dissected Jefferson City-Cotter Dolomite plains occur on the divides between the streams. In addition, unique landscapes with frequent dolomite glade knobs characteristic of this subsection also occur..."(MDC 1997a).

The Central Plateau Subsection "represents the high, flat to gently rolling plains that are the least eroded remnant of the Salem Plateau. Underlain primarily by Jefferson City-Cotter dolomites or Roubidoux sandstone/dolomite, the plains are often mantled in a thin layer of loess and have droughty soils. Streams are mainly intermittent, low gradient headwater streams that are often losing. Savannas and woodlands were originally the dominant vegetation types"(MDC 1997a).

Land Type Associations (LTAs)represent the smallest level of the three levels previously mentioned. LTAs (Figure Lu04) intersecting the North Fork Watershed include the Following:

Ava Oak Woodland Dissected Plain

Gainesville Oak Woodland Hills

Howell-Oregon Oak Woodland Dissected Plain

Romance Oak Woodland Dissected Plain

Upper Gasconade Oak Woodland Dissected Plain

Vanzant Oak Woodland Dissected Plain

West Plains Oak Savanna/Woodland Plain

Cabool-Mt. Grove Oak Savanna/Woodland Plain

Bryant Creek Oak-Pine Woodland Forest Hills

North Fork River Oak-Pine Woodland Forest Hills

North Fork Pine-Oak Woodland Dissected Plain

Gainesville Dolomite Glade/Oak Woodland Knobs

Upper Swan Creek Oak Woodland/Forest Breaks

North Fork Oak Woodland/Forest Hills

Table Lu03 gives descriptions of LTAs within the watershed.

The Ecological Classification System could prove to be a useful tool for planning and implementing natural resource management activities by providing an indication of what natural resource management options will be more adapted to specific areas thus increasing the success of management decisions as well as helping to ensure that management decisions are ecologically enhancing.

Current Land Use

The Missouri Resource Assessment Partnership (MoRAP) Phase 1 Land Cover Classification (1997) (morapmd.wpd) data indicates estimated forest/woodland cover within the North Fork Watershed at 61.9% while grassland/cropland comprises 37.5% of the total land cover (Table Lu04, Figure Lu05, Lu06, and Lu07). While forest/woodland is the dominant cover type within the 6 eleven digit hydrologic units (Upper North Fork, Upper Bryant, Lower North Fork, Lower Bryant, West Norfork Lake, East Norfork Lake) of the watershed, the Upper North Fork Hydrologic Unit contains the highest combined percentage of forest/woodland cover at 65.8 percent. This is due in large part to the fact that much of this watershed is in public ownership as part of the Mark Twain National Forest. Fourteen Digit Hydrologic Unit 30001 (a portion of the Spring Creek-North Subwatershed) has the highest percentage of forest/woodland cover at 82.9 percent. This hydrologic unit is composed of large amounts of public land. Fourteen Digit Hydrologic Unit 50005 (a portion of Norfork Lake Drainage) has the lowest percentage of forest/woodland cover at 22.7 percent (Figure Lu07).

Soil Conservation Projects

As of May 1997, the Douglas and Ozark Counties' Soil and Water Conservation Districts and the Natural Resources Conservation Service are sponsoring a 319 Project in the tributaries of the Bryant Creek watershed which lay in both Douglas and Ozark Counties (Figure Lu08). Other participants include the University of Missouri Cooperative Extension Service, Missouri Department of Natural Resources, and Consolidated Farm Services Agency. The Missouri Department of Conservation is also providing technical advice (Pratt, personal communication). The watershed contains 250,000 acres with a concentration of approximately 70 dairies, 5000 dairy cows and 30,000 beef cattle. The purpose of the project "proposes demonstration practices and an information program to improve or maintain water quality within the tributaries of the Bryant Creek Watershed in Douglas and Ozark Counties." The project is planning 10 BMP (Best Management Practice) demonstration areas. These will include 3 animal waste management farms, 4 grazing management farms, and 3 riparian corridor management/protection farms with alternative watering systems. The project is scheduled to be

completed in June of 2002.

Three Special Area Land Treatment (SALT) projects have been located in the North Fork Watershed (CARES 1999). These project areas are the Becky Cobb Creek Watershed (1253 acres treated), Bird Town Hollow Watershed (2470 acres treated), and Clifty Creek Watershed (1450 acres treated). All three projects have ended with the last one, Clifty Creek, ending in mid-summer of 1999 (Figure Lu08)(CARES 1999 and Bruffett, personal communication).

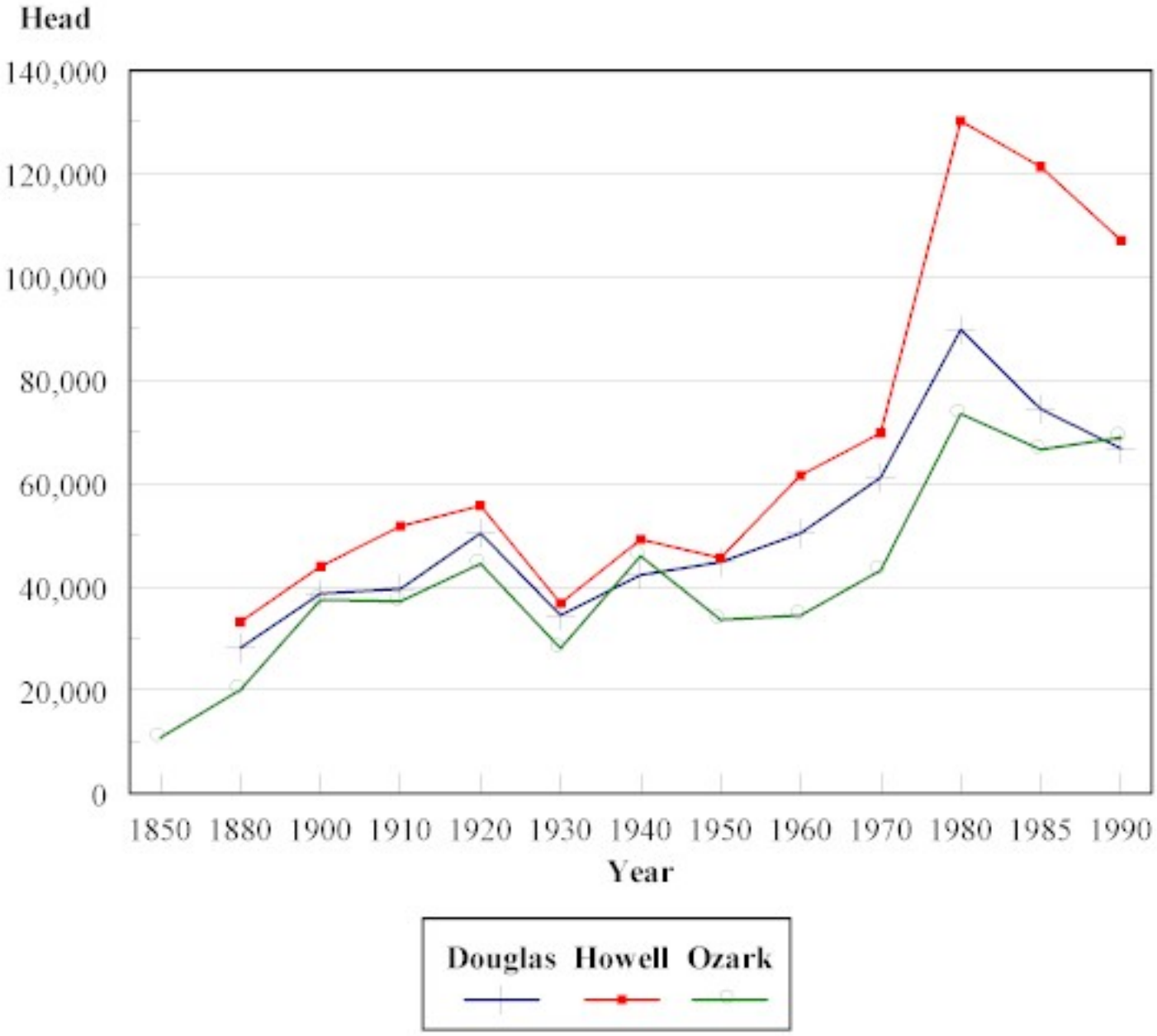
Public Areas

The North Fork Watershed contains approximately 115,205 acres (13.0%) of public land. (Table Lu05 and Figure Lu09). Approximately 89% (102,365 acres) of the public land is part of the Mark Twain National Forest managed by the United States Forest Service. Within the watershed, the United States Army Corps of Engineers (USACOE) owns approximately 5,150 acres in association with Norfork Lake. The Missouri Department of Conservation owns approximately 10,075 acres on 14 areas within the Watershed (MDC 1995). The largest MDC area within the watershed is Caney Mountain Conservation Area which is comprised of 6,674 acres (5,192 acres within the watershed). The MDC also leases an additional 5,150 acres of USACOE property bordering Norfork Lake in Missouri (MDC 1995).

There are 4 public accesses with boat ramps on USACOE property on Norfork lake in Missouri. The United States Forest Service has three public stream accesses. These are located at the North Fork Recreation Area off of CC Highway in Ozark County, Hale Crossing on County Road 275 in Douglas County, and Osborn Crossing located on County Road AH-260 in Douglas County. None of these accesses have a boat ramp. Currently stream access and/or frontage to permanently flowing streams exist on 9 of the 15 areas owned by the Missouri Department of Conservation within the watershed. Of these, 3 areas have boat ramps.

The Missouri Department of Conservation Stream Areas Program Strategic Plan (McPherson 1994) includes the acquisition of two stream access sites within the North Fork Watershed. Also planned within the watershed, through the Stream Areas Program Strategic Plan (McPherson 1994), is the eventual acquisition of eight stream frontage tracts. In addition to expanding public use and access, frontage tracts can provide the preservation of representative, threatened, remnant, or critical stream habitats. Acquisition of these access sites and frontage tracts will be dependent on property availability and site suitability.

Figure Lu01. Cattle and hog population trends for Douglas, Howell, and Ozark Counties (MASS 1999).



FigureLu02. Human population trends for Douglas, Howell, and Ozark Counties (OSEDA 1998).

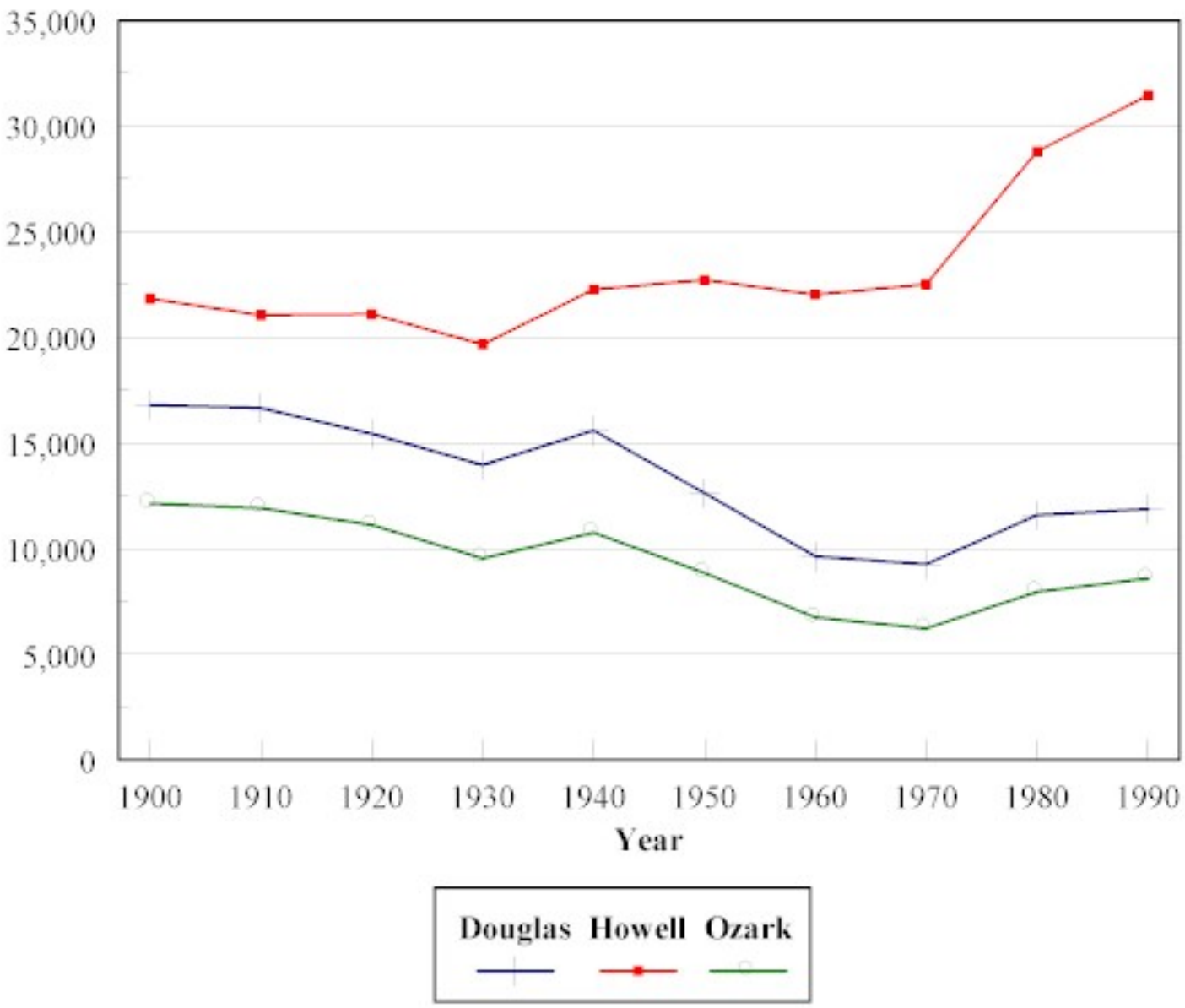
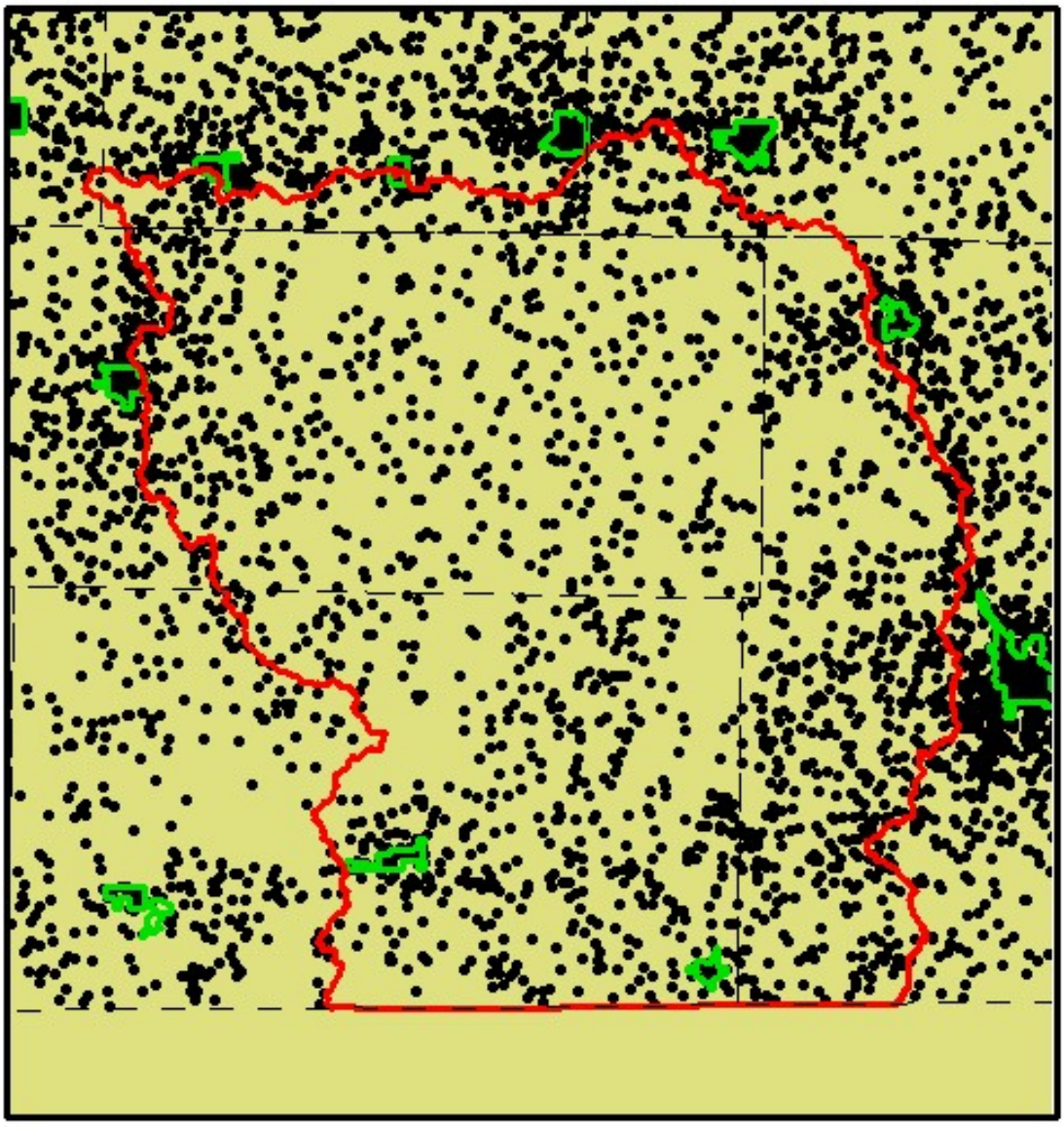


Figure Lu03.

North Fork Watershed
Population



4 0 4 8 Miles

Legend

- Watershed Boundary
- County Boundary
- City

Population Distribution *

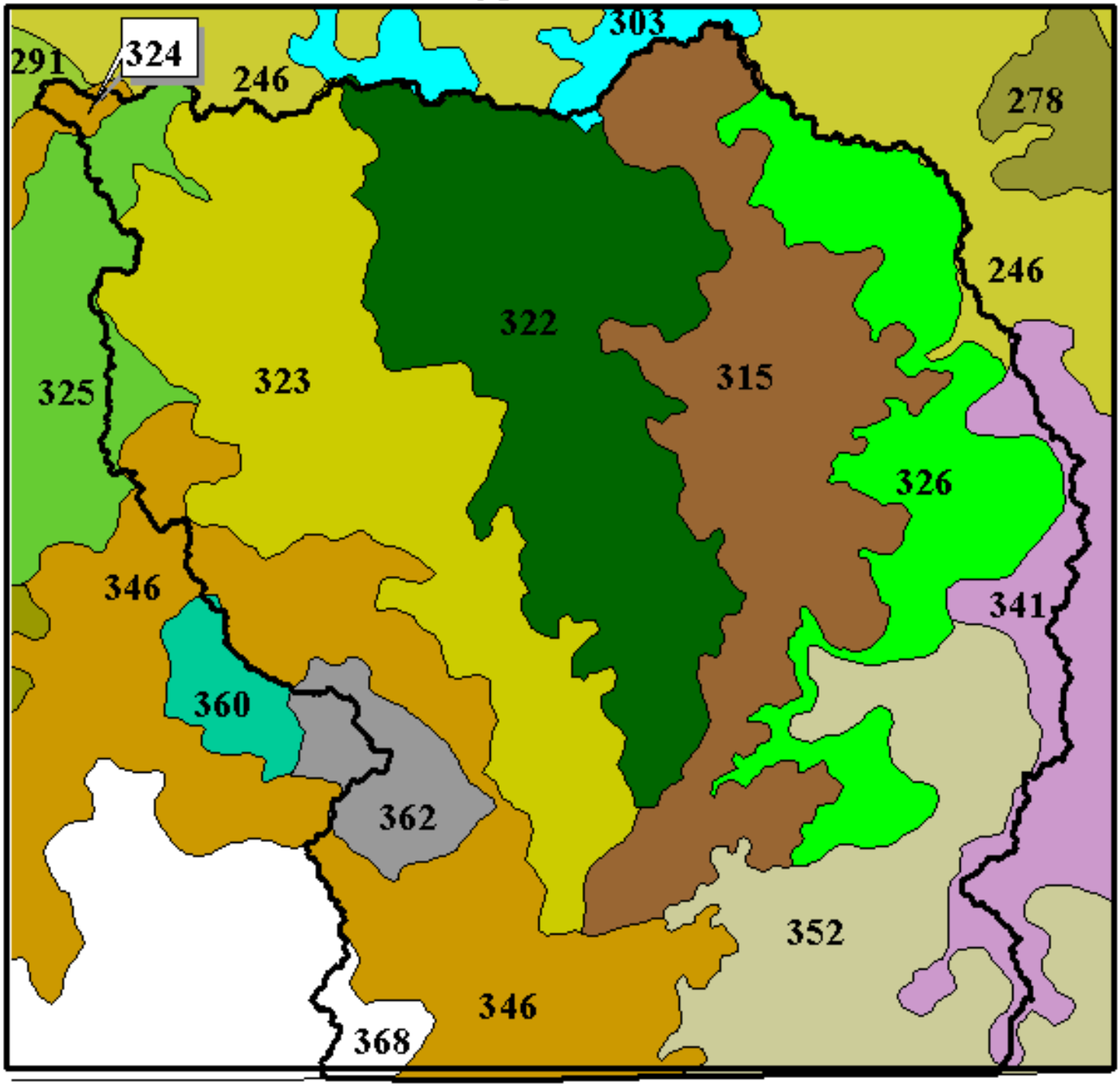
- One dot = 10 persons

*Based on census blocks

N

Figure Lu04.

North Fork Watershed
Land Type Associations



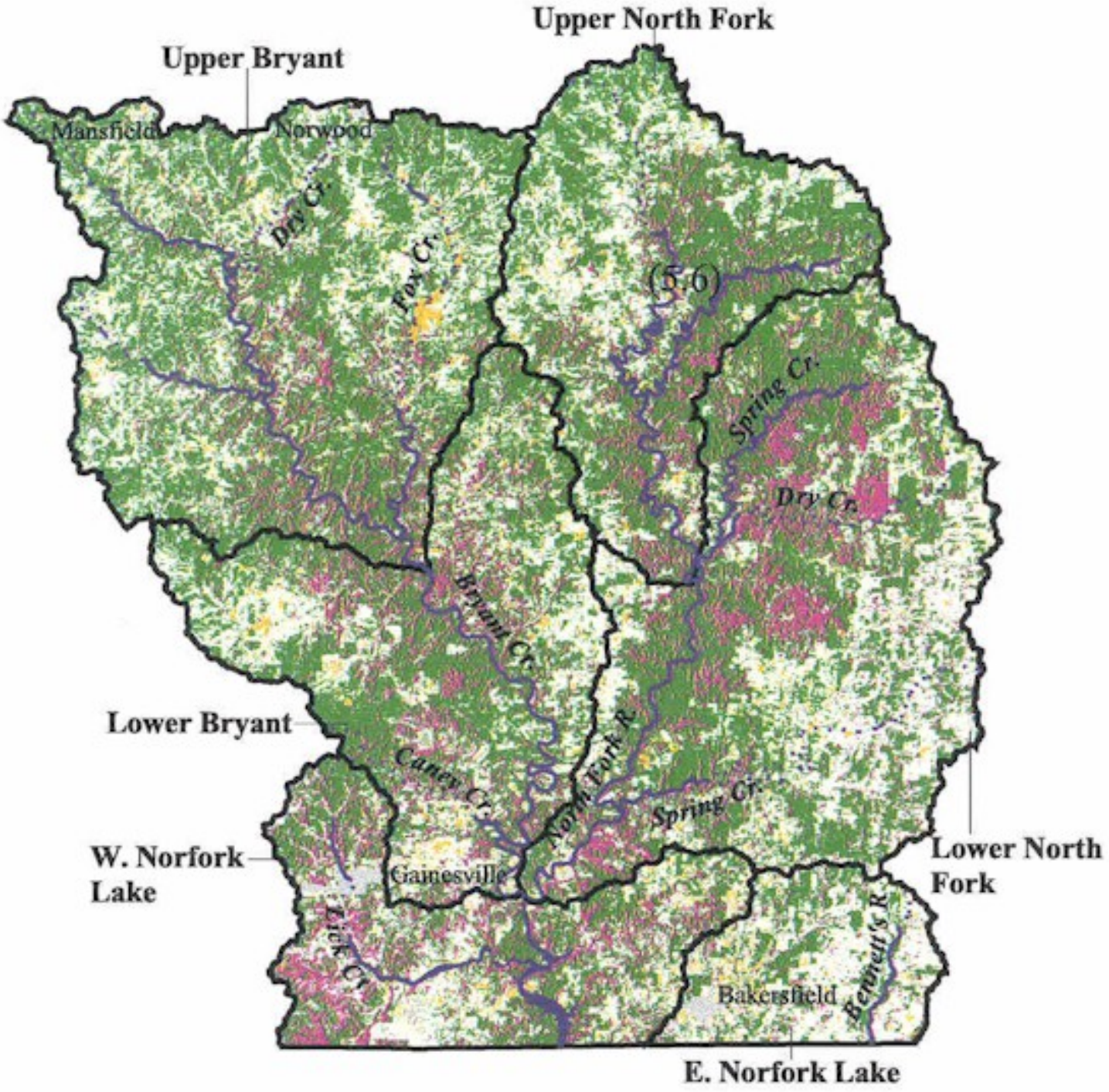
Legend

- Watershed Boundary
- Ava Oak Woodland Dissected Plain (325)
- Bryant Creek Oak-Pine Woodland/Forest Hills (323)
- Cabool - Mt. Grove Oak Savanna/Woodland Plain (303)
- Gainesville Dolomite Glade/Oak Woodland Knobs (362)


Gainesville Oak Woodland Hills (346)
Howell-Oregon Counties Oak Woodland Dissected Plain (352)
Little North Fork Dolomite Glade/Oak Woodland Hills (368)
North Fork Pine-Oak Woodland Dissected Plain (326)
North Fork River Oak-Pine Woodland/Forest Hills (315)
Romance Oak Woodland Dissected Plain (360)
Seymour Highland Oak Savanna Dissected Karst Plain (291)
Upper Gasconade Oak Woodland Dissected Plain (246)
Upper Swan Creek Dolomite Glade/Oak Forest Breaks (324)
Van Zant Oak Woodland Dissected Plain (322)
West Plains Oak Savanna/Woodland Plain (341)

Figure Lu05.

North Fork Watershed
Land Cover/Land Use



4 0 4 8 Miles

Legend

Eleven Digit Hydrologic Unit Boundary

Land Cover*

N

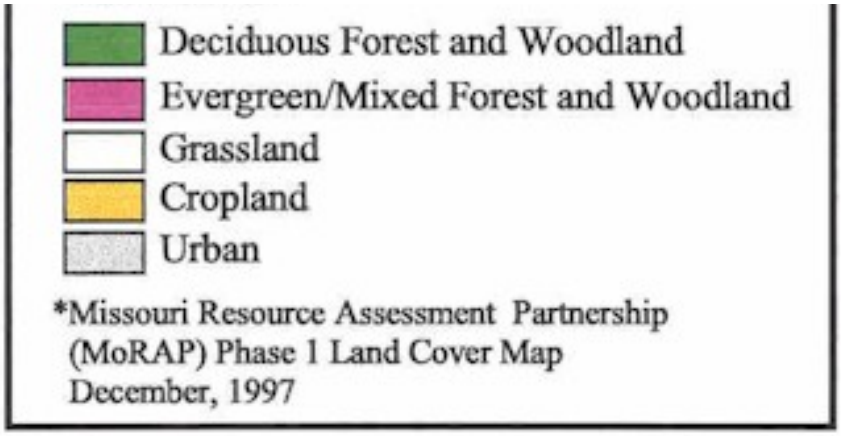
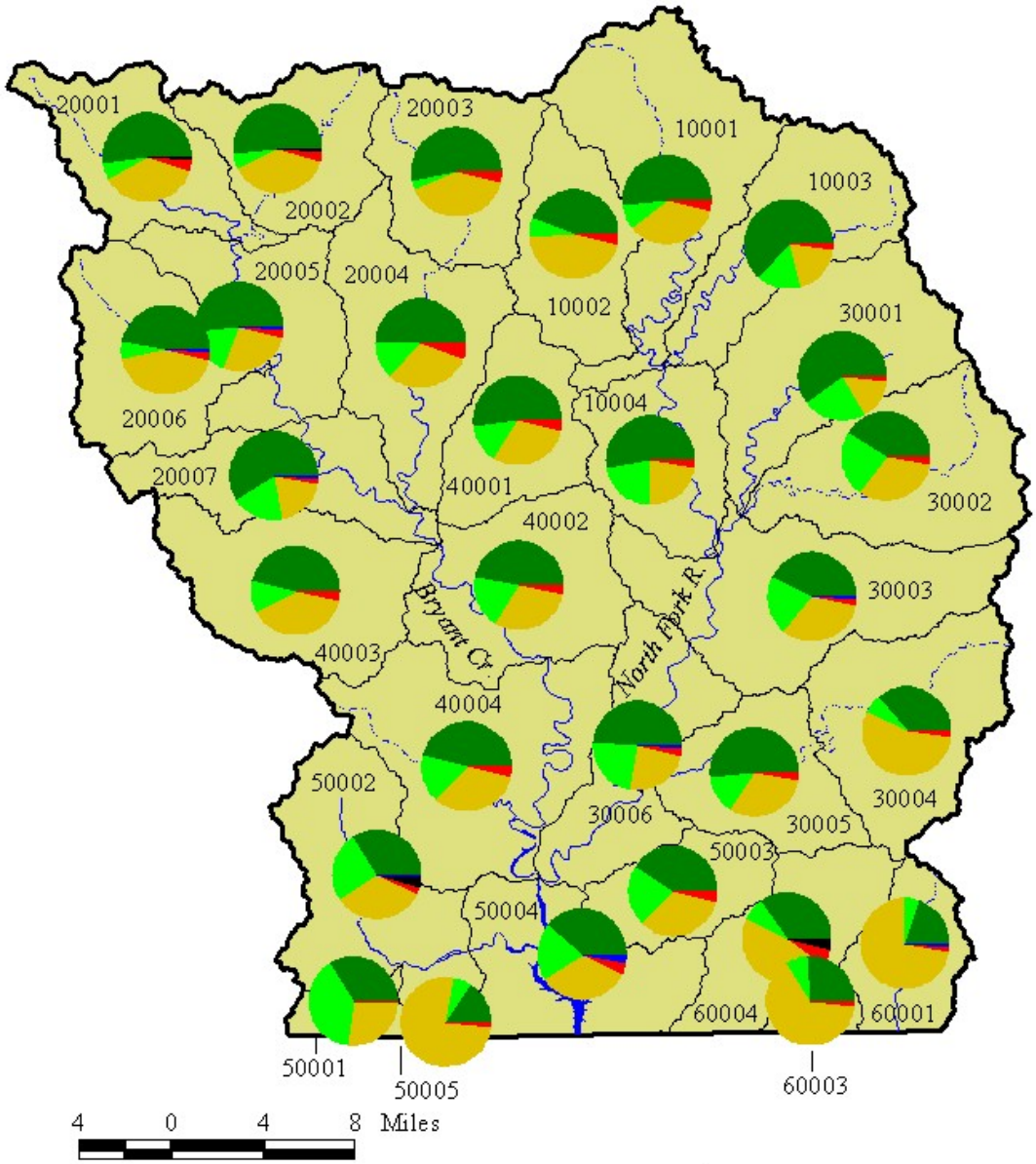

Deciduous Forest and Woodland
Evergreen/Mixed Forest and Woodland
Grassland
Cropland
Urban
*Missouri Resource Assessment Partnership
(MoRAP) Phase 1 Land Cover Map
December, 1997

Figure Lu06.

North Fork Watershed

14 Digit Hydrologic Unit Land Cover/Land Use



Legend

- 14 Digit Hydrologic Unit Boundary

Land Cover*

- Forest
- Woodland
- Grassland
- Cropland
- Urban
- Water

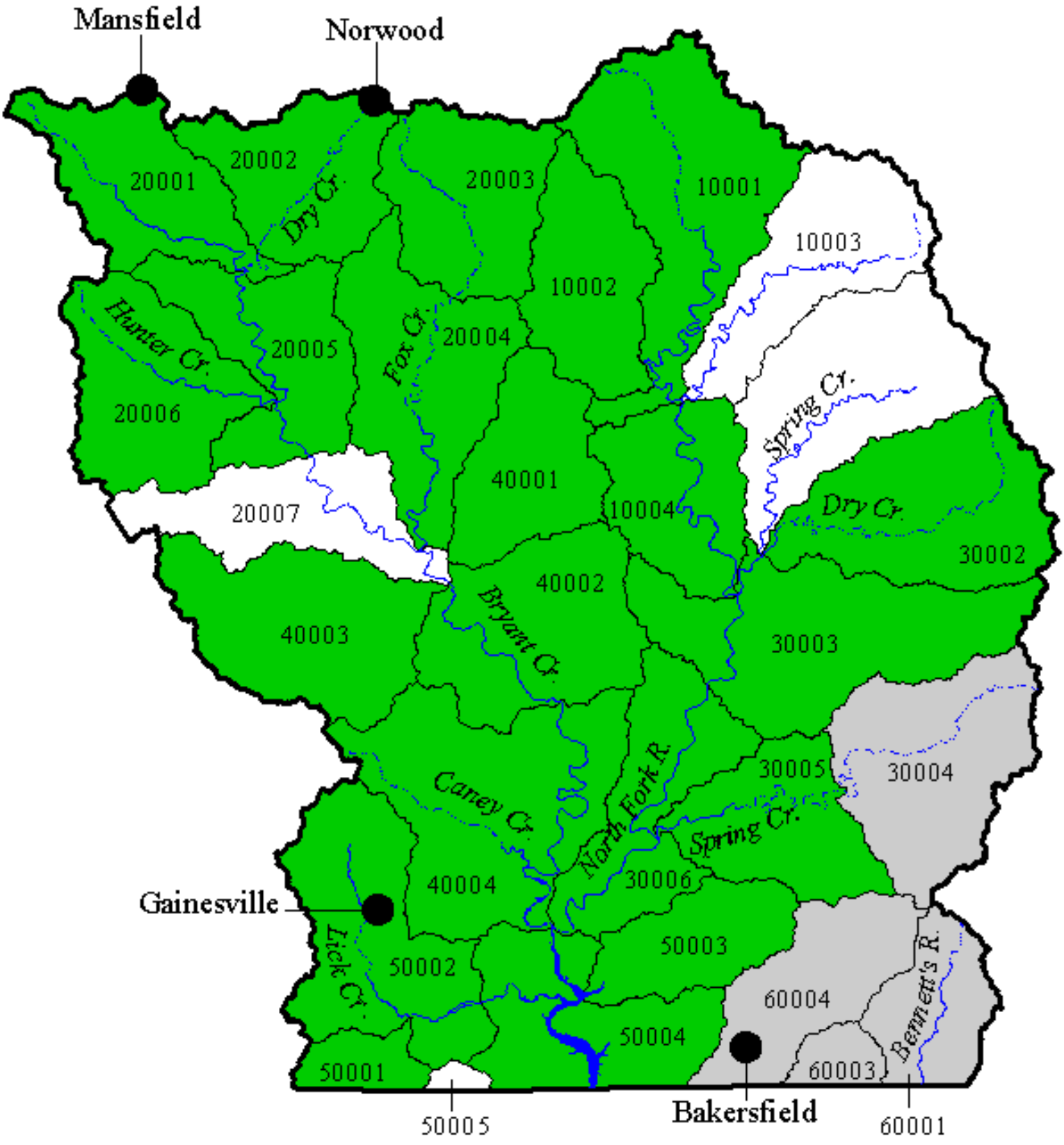
*Based on analysis by Caldwell (1999) of Missouri Resource Assessment Partnership (MoRAP) Phase 1 Land Cover Map December, 1997

N

Figure Lu07.

North Fork Watershed

14 Digit Hydrologic Unit Forest Woodland Cover



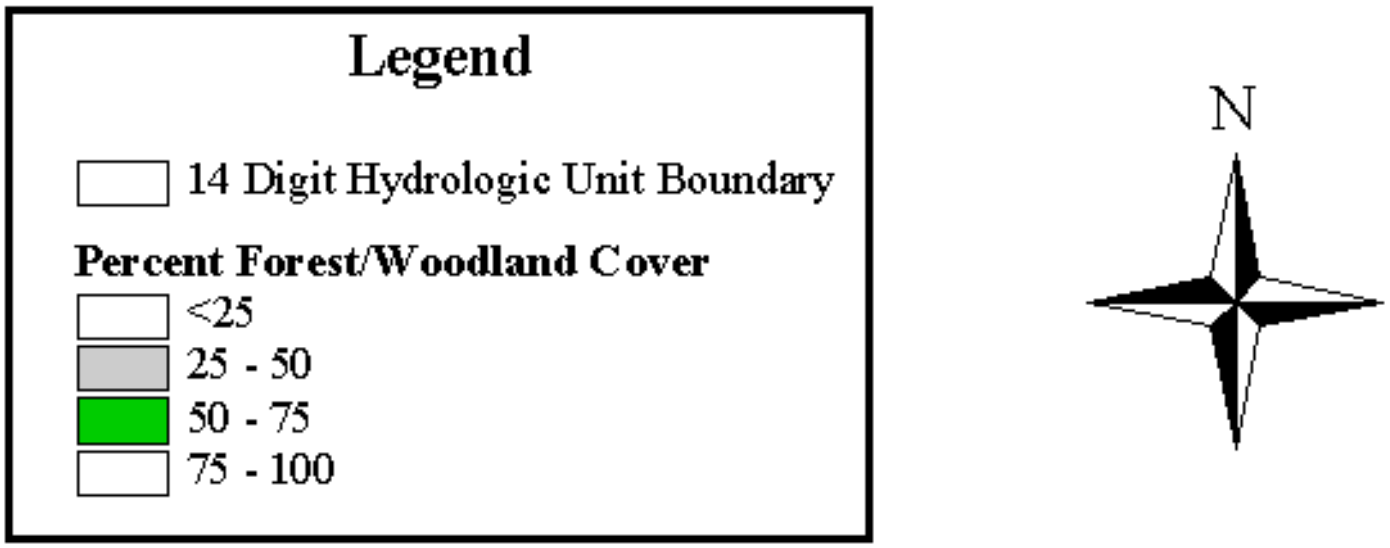
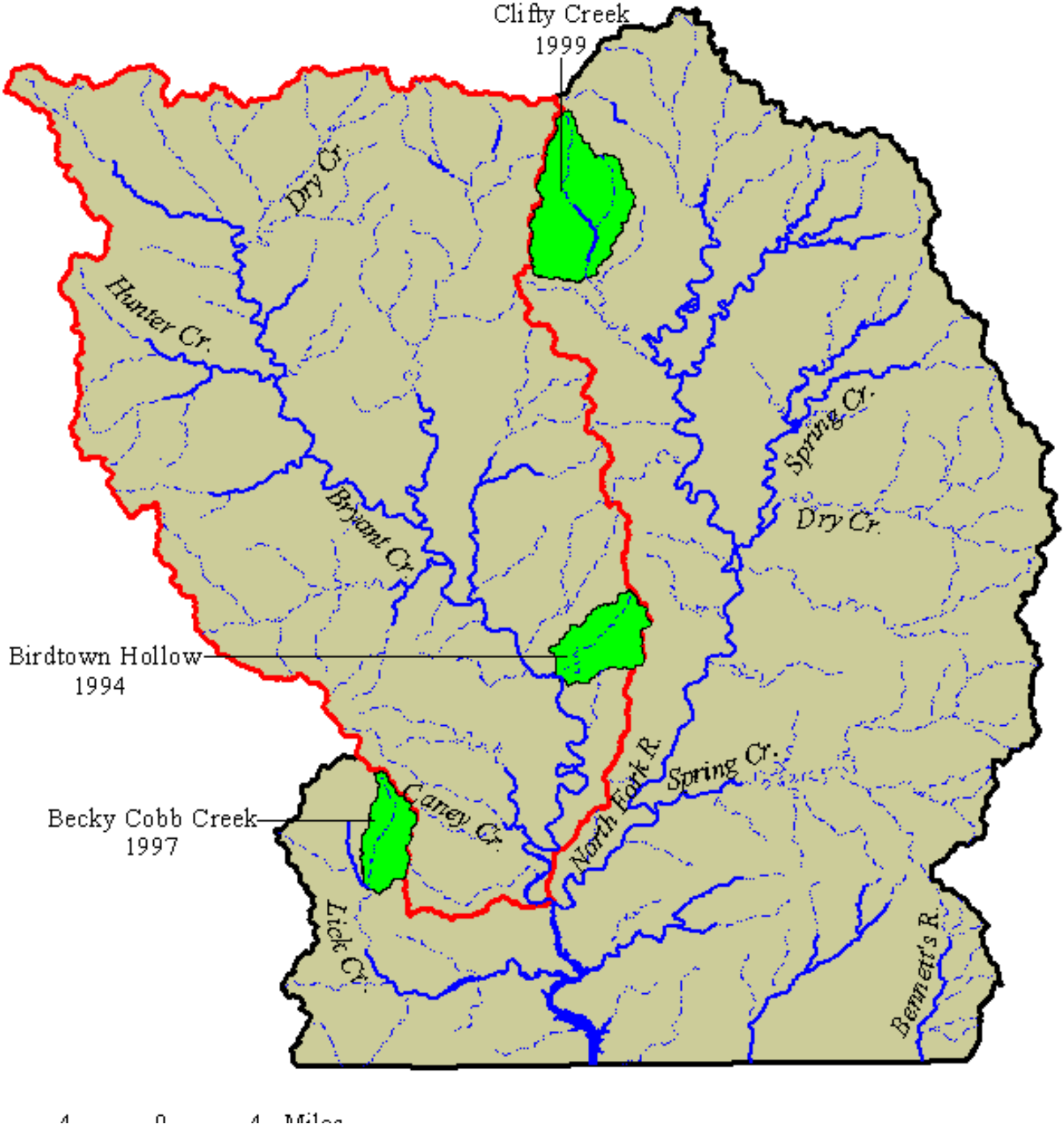
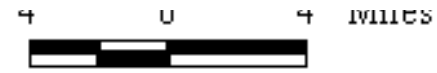

Legend
14 Digit Hydrologic Unit Boundary
Percent Forest/Woodland Cover
<25
25 - 50
50 - 75
75 - 100
N

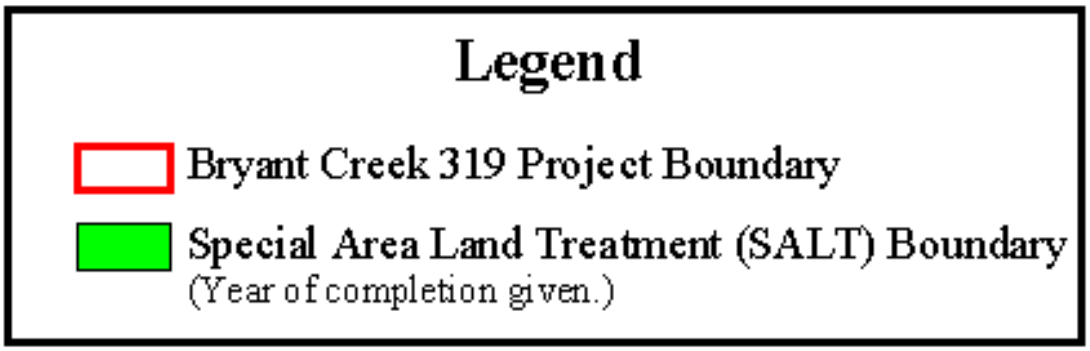
Figure Lu08.

North Fork Watershed
Soil Conservation Projects



4 0 4 Miles


4 0 4 Miles


Legend
Bryant Creek 319 Project Boundary
Special Area Land Treatment (SALT) Boundary
(Year of completion given.)


N

Figure Lu09.

North Fork Watershed
Public Land

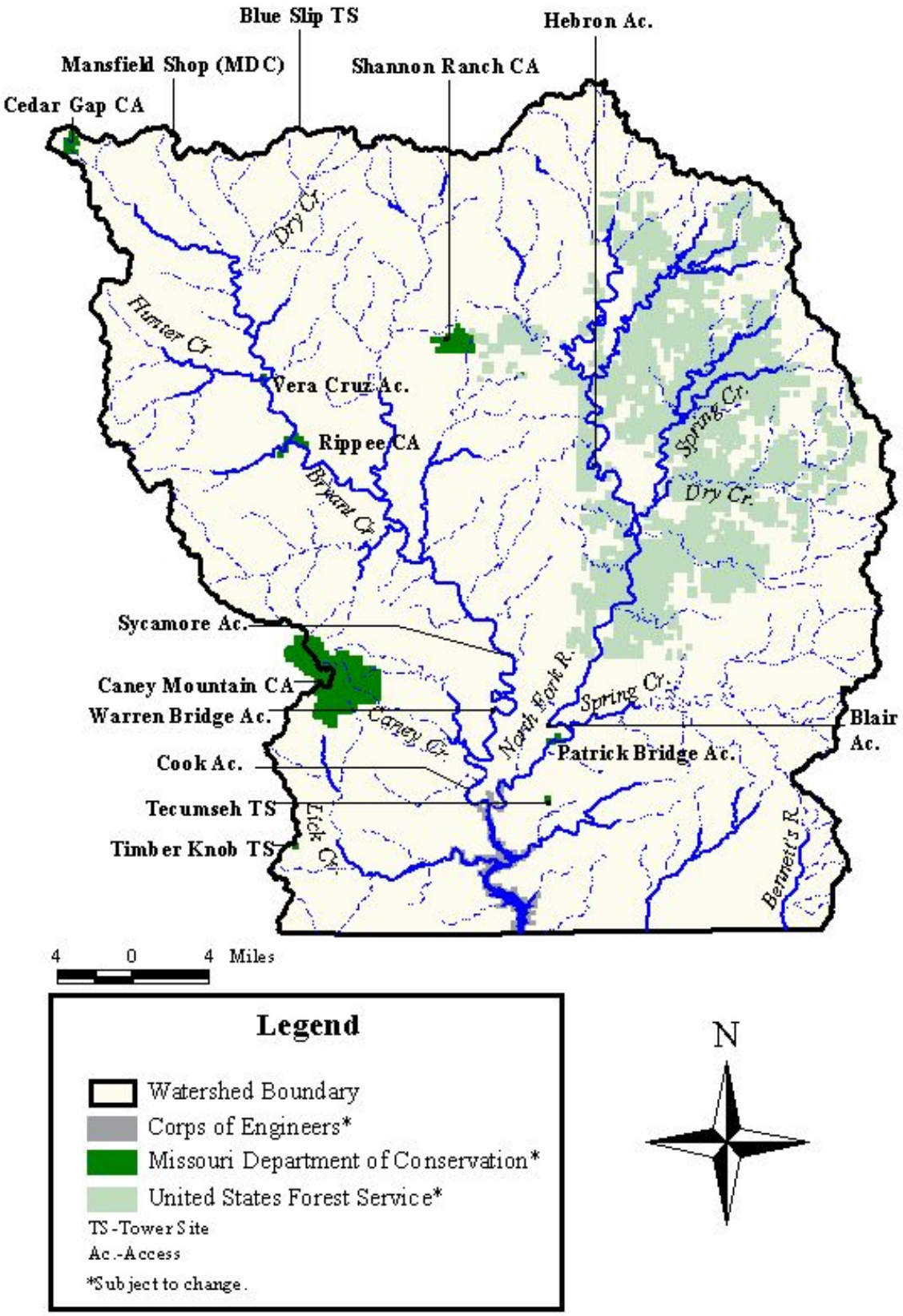


Table Lu01. Estimated acres of selected crops harvested in Douglas, Howell and Ozark Counties in 1902 and 1997 (MASS 1999).

Crop	Douglas		Howell		Ozark	
	1899 Acres	1996 Acres	1899 Acres	1996 Acres	1899 Acres	1996 Acres
Corn	43,288	<500	43,737	<500	32,183	<500
Hay	13,102	38,900	12,857	47,800	3,577	19,900
Wheat	15,078	<500	29,284	<500	12,025	<500

Table Lu02. Land cover/ land use change from pre-settlement period conditions (1820's) to the 1970's in the Jack's Fork Watershed, Missouri (Jacobson and Primm 1994).

1820's		1970's		%
Category	**Area sq. miles**	**Category**	**Area sq. miles**	
Shrub and brush rangeland	55.4	Urban/developed	1.6	3
		Pasture/cropland	26.5	48
		Deciduous forest	27.3	49
Deciduous forest	242.0	Pasture/cropland	59.9	25
		Deciduous forest	178.6	75
Evergreen forest	3.5	Deciduous forest	3.5	100
Mixed forest	323.1	Pasture/cropland	34.5	11
		Deciduous forest	281.6	87
		Mixed forest	7.0	2
Barrens	29.2	Pasture/cropland	15.5	53
		Deciduous forest	13.7	47

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed (1 of 6) description of the 15 LTAs (underlined in bold) within the North Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Oak Woodland Dissected Plains and Hills Group

Landform: Distinguished by rolling to moderately dissected topography. Local relief is 75-150 feet. Very broad, flat ridges give way to gentle side slopes and broad stream valleys. Karst plains with frequent shallow sinkhole depressions are common. Broad stream valleys most often occupied by losing streams, however occasional seeps do occur and can spread across substantial portions of a valley.

Geology: Commonly underlain by Jefferson City-Cotter dolomites with a common loess cap. Some minor areas underlain by Roubidoux sandtones.

Soils: Soils are variable, ranging from shallow to bedrock and fragipan soils, to deep, cherty and well-drained loams. Tree root growth is often restricted by bedrock, pans or clay mineralogy, especially high in the landscape.

HistoricVegetation: Open woodlands with occasional prairie and savanna openings was the principal vegetation type. Post oak and black oak were the principal woodland tree species. Historic fire likely played an important role in maintaining an open canopy, sparse understory and a dense herbaceous ground flora. More dissected lands likely contained mixed oak woodland and forest. Unique sinkhole ponds, wet prairies and seeps were scattered in the broad valleys and depressions.

Current Conditions: Currently a mosaic of fescue pasture (35-65% cover) and dense, often grazed oak forest. The transition from open grassland to closed forest is abrupt and the patch work blocky. Very few native grasslands or savannas are known, and the dense second growth woodlands have very little ground flora. Most sinkoles, wet prairies and seeps have been drained and heavily grazed. Many roads, towns, cities and businesses are located in these LTAs.

Ava Oak Woodland Dissected Plain: Gentle Dissected Plains in headwaters of Beaver Creek.

Gainville Oak Woodland Hills: Dissecte Hills in upper reaches of Little North Fork Drainage. This LTA is more dissected and timbered than others in group.

Howell-Oregon Oak Woodland Dissected Plain: Dissected Plain in southern Howell and Oregon Counties. More dissection, better soils, and more existing timber than most other LTAs in this group.

Romance Oak Woodland Dissected Plain: Small dissected plain on divide between Little North Fork and Bryant Creek.

Upper Gasconade Oak Woodland Dissected Plain: Broad divide encompassing the headwaters of the Big Piney and Gasconade River Watersheds.

Vanzant Oak Woodland Dissected Plain: Divide between North Fork River and Bryant Creek.

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed (2 of 6) description of the 15 LTAs (underlined in bold) within the North Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Oak Savanna/Woodland Plains Group

Landform: Very broad flat uplands slope gently to very broad flat drains or solution (karst) depressions. Local relief is less than 75 feet.

Geology: Underlain mainly by Jefferson City-Cotter dolomites with a common loess cap. Minor areas of the Roubidoux formation occur. Headwater streams are nearly all losing.

Soils: Fragipan soils or soils with shallow restrictive clays or bedrock are common, inhibiting tree root growth.

HistoricVegetation: Oak savannas and woodlands with common prairie openings were the predominant historic vegetation. While few prairies were named by original land surveyors, early descriptions portray an open, "oak prairie" landscape. Fire likely played a principal role in maintaining a grassland-open woodland structure. Some sinkhole depressions would have had unique ponds and seeps.

Current Conditions: The largest blocks and greatest acres of grassland (45-65% cover) are currently associated with these LTAs; grasslands are mainly fescue pasture. Less than 40% of these LTAs are timbered, mainly in dense, second growth oak forest (post and black oaks) with common grazing pressure. Very few quality native prairies, savannas, woodlands, sinkhole ponds or seeps are known. Many of the regions roads, towns, and businesses are associated with these LTAs.

West Plains Oak Savanna/Woodland Plain: Very extensive, flat upland in the center of Howell County.

Cabool-Mt. Grove Oak Savanna/Woodland Plain: Two narrow, high, flat divides between the Upper Gasconade and North Fork Drainages.

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed (3 of 6) description of the 15 LTAs (underlined in bold) within the North Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Oak-Pine Woodland Forest Hills Group

Landform: Mainly broad ridges, moderately sloping (<25%) side slopes, and relatively broad entrenched valleys with local relief between 150-250 feet. Steeper, more dissected areas occur locally near larger stream valleys. Sinkhole depressions are common on broader ridges. Stream valleys vary somewhat from broad and rather shallow, to more deeply entrenched, narrow, and meandering. Many losing streams occur in valleys distant from the main rivers. Cliffs, caves and springs are commonly associated with larger, perennial stream valleys.

Geology: Roubidoux cherty sandstones and dolomites occupy most ridges and upper side slopes, while lower side slopes, especially near major streams are in cherty upper Gasconade dolomite materials.

Soils: Soils are mainly deep, highly weathered and very cherty silt loams with clays at varying depth. Broad ridges may have a loess cap with occasional fragipans, and shallow soils with dolomite bedrock near the surface occur frequently on steeper, exposed slopes.

Historic Vegetation: Pine and mixed oak-pine woodland originally dominated the more gently sloping upland surface associated with the Roubidoux Formation. Early descriptions portray an open, grassy and shrubby understory in these woodlands, a condition related to the prevalence of fire in the historic landscape. Oak and oak-pine forest occupied lower slopes and more dissected, hilly parts of these landscapes, as well as the wider and more well-drained bottom. Bottoms with richer alluvial soils and more abundant water likely were forested in mixed hardwood timber. Dolomite glade and open savanna/woodland complexes were common on exposed slopes with shallow soils. Sinkhole ponds and fens were dotted occasionally throughout.

Current Conditions: Mainly forested in second growth oak and oak-pine forests; forest cover ranges from sixty to over 80%. Most forests are rather dense, near even-age second growth, with very little woodland ground flora. The occurrence of shortleaf pine in these forests has diminished from its original extent, today having only 20-30% of the forest cover containing a substantial component (>25%) of pine. Even age stands dominated by scarlet, black, and white oak are common, oak die back is a common problem. Much of the existing timber land is associated with public land ownership. Cleared pasture lands occupy many of the broad stream valleys and highest, flattest ridges. Many glades and woodlands suffer from woody encroachment, and sinkhole ponds and fens have been drained or severely overgrazed. An exceptional proportion of state-listed species sites are associated with the streams, springs, caves, cliffs, fens, and sinkhole ponds in this group.

Bryant Creek Oak-Pine Woodland Forest Hills: Includes most of the valley. This LTA has the lowest relief, forest cover, and pine component in group.

North Fork River Oak-Pine Woodland Forest Hills: Include most of valley; exceptional pine component and U.S. Forest Service ownership.

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed (4 of 6) description of the 15 LTAs (underlined in bold) within the North Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Pine-Oak Woodland Dissected Plains

Landform: Broad, flat to gently rolling plains which give way to moderately dissected and sloping lands associated with the headwaters of major drainages. Valleys are broad and local relief 100-150 feet. Clusters of karst sinkholes are common. Streams are mainly headwater streams with flashy, intermittent flow.

Geology: Underlain by cherty sandstone and dolomite of the Roubidoux Formation with frequent loess deposits on the flatter uplands.

Soils: Soils are formed principally in cherty sandstone and dolomite residuum from the Roubidoux Formation. Soils are mainly deep, cherty, and highly weathered, low base soils. However occasional fragipans and shallow to bedrock soils do occur. Most soils are extremely well drained and droughty.

HistoricVegetation: Originally covered in woodlands of shortleaf pine and mixed pine oak with an open understory of dense grass and shrub ground cover. Post oak woodlands occupied occasional loess covered flats. Unique sinkhole ponds dotted the landscape.

Current Conditions: Over 75% of this group are currently forested in dense, even-age oak and oak-pine forest. Only 20% of these forests have a strong pine component. However, the proportion of forests containing shortleaf pine is the highest in this group. Dense stands of near even age scarlet, black, and post oak occur in the place of pine. Understories are dense, woodland ground flora sparse, and oak die-back common. A substantial component of these forested lands are publicly owned. Approximately 20% of this group is currently pasture, which often occupies the broad valley bottoms or karst plains. Most sinkhole ponds have been drained, dozed or severely overgrazed. Headwater streams are subject to grazing and bank erosion.

North Fork Pine-Oak Woodland Dissected Plain: Flat to rolling landscape along the eastern edge of the North Fork Hills.

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed (5 of 6) description of the 15 LTAs (underlined in bold) within the North Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Dolomite Glade/Oak Woodland Knobs

Landform: Prominent dolomite knobs and high extended ridges which, as erosional remnants, rise above the surrounding landscape.

Geology: Jefferson City-Cotter dolomites form the core of this landscape. Knobs often have a cap of cherty Mississippian limestone. The cap often exists as residual, very cherty sediments left from millennia of erosion.

Soils: Soils in the uplands are mainly shallow to bedrock with varying amounts of cherty residual overburden. The thin soils support extensive unique dolomite glade and oak savanna/woodland complexes. Deeper soils are mainly cherty loams formed from the cherty residual limestone and dolomite materials.

HistoricVegetation: Extensive open and thinly wooded areas. Oak woodland and forests were confined to the roughest land and valleys. The extensive open glades and savannas supported numerous unique species, many found only on these habitats in the White River Hills subsection. Fire history studies indicate frequent (3 year fire free interval) fire in these landscapes prior to settlement

Current Conditions: Most of the dolomite glades and woodlands have grown up in thick stands of eastern red cedar and other invaders. In addition, widespread grazing pressure has lowered the diversity of many glade/woodland areas. Efforts to reintroduce fire and eliminate woody species encroachment has had substantial success on a limited number of acres. Caney Mountain C.A. and the Ava District of the Mark Twain National Forest encompass a significant portion of these LTAs.

Gainesville Dolomite Glade/Oak Woodland Knobs: Encompasses the Gainesville Monadocks, a prominent set of unique knobs. Caney Mountain C.A. occupies a large portion of this LTA.

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed (6 of 6) description of the 15 LTAs (underlined in bold) within the North Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Oak Woodland Hills and Breaks

Landform: This Group exhibits relatively rough topography with local relief of 150-250 feet. The Upper Swan Creek Breaks represent a more abrupt steep and intricately dissected landscape than the North Fork Hills.

Geology: The Geology of this Group is primarily composed of the Jefferson City-Cotter formations. Scattered dolomite knobs are interspersed through relatively rugged hills. In addition the uplands in Upper Swan Creek frequently have a cap of cherty Mississipian limestone.

Soils: Areas of shallow soils are frequent with deeper cherty loam soils above and below them.

HistoricVegetation: Likely, common dolomite glade and cherty savanna/woodland complexes on steep sideslopes. Oak woodland and forest occupied deeper soils, especially along valleys.

Current Conditions: Broader, flat to gently rolling uplands and broad bottoms are currently fescue pasture. This is especially true in the North Fork Hills. Glades and Savannas are extensively overgrown with eastern red cedar and other woody species; and suffer from a history of intense grazing. Forest consists of mainly second growth oak in various mixes. Mainly private ownership.

Upper Swan Creek Oak Woodland/Forest Breaks: Rugged hills with abrupt breaks into upper Swan Creek Valley.

North Fork Oak Woodland/Forest Hills: More typically rolling to dissected hills landscape with common glade/woodland complexes.

Table Lu04. Percent land use for 14 digit and 11 digit (in bold) hydrologic units within the North Fork Watershed. Data is based on MORAP Phase 1 Land Cover (1997) as analyzed by Caldwell (1998).

Subwatershed	FOR	WDL	GRS	CRP	URB	WAT
10001	51.9	9.2	35.2	3.5	<0.1	<0.1
10002	43.6	6.7	45.3	4.5	0	<0.1
10003	63.2	15.7	19.1	1.9	0	0.1
10004	52.9	21.5	22.6	2.8	0	0.2
Upper North Fork	**53.2**	**12.6**	**30.9**	**3.2**	**<0.1**	**0.1**
20001	51.9	6.2	37.5	3.7	0.6	<0.1
20002	51.8	5.4	37.8	3.8	1.2	<0.1
20003	52.9	3.3	39.6	4.1	0	<0.1
20004	50.2	13.0	31.0	5.7	0	<0.1
20005	52.3	17.4	27.2	3.0	0	0.1
20006	47.2	5.7	43.4	3.5	0.2	<0.1
20007	59.4	19.3	18.8	2.3	0	0.2
Upper Bryant	**52.0**	**10.1**	**33.8**	**3.8**	**0.3**	**<0.1**
30001	60.2	22.8	15.0	1.9	0	0.3
30002	41.1	23.6	32.4	2.5	0	<0.1
30003	43.4	20.9	33.5	2.0	0	0.2
30004	36.1	6.9	55.1	1.8	0	<0.1
30005	51.9	14.1	30.8	3.2	0	<0.1
30006	49.4	22.6	24.3	3.0	0	0.7
Lower North Fork	**46.6**	**18.7**	**32.5**	**2.3**	**0**	**0.2**
40001	52.3	13.7	29.8	4.1	0	<0.1

40002	46.8	18.9	30.9	3.2	0	0.2

FOR =Forest, **WDL**=Woodland, **GRS**=Grassland, **CRP**=Cropland, **URB**=Urban, **WAT**=Water

Table Lu04. Percent land use for 14 digit and 11 digit (in bold) hydrologic units within (continued) the North Fork Watershed. Data is based on MORAP Phase 1 Land Cover (1997) as analyzed by Caldwell (1998).

Subwatershed	FOR	WDL	GRS	CRP	URB	WAT
40003	45.7	11.7	38.2	4.3	0	0.1
40004	45.7	17.5	32.7	3.7	0.1	0.3
Lower Bryant	**47.0**	**15.7**	**33.2**	**3.8**	**<0.1**	**0.2**
50001	34.2	38.6	25.9	1.2	0	0
50002	34.4	25.2	34.0	2.4	4.0	<0.1
50003	41.5	21.6	32.7	4.2	0	<0.1
50004	38.8	19.8	34.5	4.0	<0.1	3.1
50005	16.4	6.2	75.8	1.6	0	0
West Norfork Lake	**36.9**	**23.5**	**33.9**	**3.1**	**1.6**	**1.0**
60001	20.2	5.4	71.9	2.5	0	<0.1
60003	25.9	8.0	64.5	1.6	0	0
60004	35.2	8.1	47.4	5.6	3.7	<0.1
East Norfork Lake	**28.7**	**7.1**	**58.2**	**4.0**	**1.9**	**<0.1**
North Fork Watershed	**46.9**	**15.0**	**34.2**	**3.3**	**0.4**	**0.2**

FOR =Forest, **WDL**=Woodland, **GRS**=Grassland, **CRP**=Cropland, **URB**=Urban, **WAT**=Water

Table Lu05. Public lands within the North Fork Watershed. For areas only partially within the watershed, total acreage is given in parenthesis. (MDC 1995).

Name	Owner[1]	Acres2	Stream (miles)3
Blair Bridge Access	MDC	7.0	0.2
Blueslip Towersite	MDC	3.6 (4.6)	0
Cedar Gap CA	MDC	384.0	0
Caney Mountain CA	MDC	5192.0 (6,674.0)	0
Florence C. Cook Access	MDC	4.7	0.4
Hebron Access	MDC	12.0	0.3
Mark Twain National Forest	USFS	102,365.0	46.2
Norfork Lake	USACOE	5,150.0	2.5
Patrick Bridge Access*	MDC	161.0	1.1
Rippee CA	MDC	418.0	2.5
Shannon Ranch CA	MDC	1,325.0	0
Sycamore Access*	MDC	16.0	0.3
Tecumseh Towersite	MDC	40.0	0
Timber Knob Towersite	MDC	40.0	0
Vera Cruz Access	MDC	80.0	0.6
Warren Bridge Access*	MDC	7.0	0.3
TOTAL	-	**115,205**	54.4

Note: This table is not a final authority. Data subject to change.

[1]Owner: MDC=Missouri Department of Conservation.

USCOE=United States Corps of Engineers.

USFS=United States Forest Service.

[2]Estimates are approximate.

[3]Permanent Stream (Estimates are approximate.)

*No boat ramp at access.